A Guide to Designing a Community Water Conservation Program

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Introduction

Although water is essential for life, most people take it for granted. They view water as an inexpensive and unlimited resource. People are satisfied as long as an unlimited supply of good quality water is available. However, water supplies in this country are no longer unlimited. In many parts of the country, future water supplies are uncertain, and escalating water development costs have become a serious obstacle to expanding water supplies.

Public officials at all levels of government are increasingly convinced of the importance of community-level water conservation programs to reduce the demand on the nation's water resources. Various strategies can be used as part of a community water conservation program. These include:

- Public education programs;
- Refit programs (installing water saving devices in older plumbing fixtures);
- Water rate structure revisions;
- Programs to reduce water loss in distribution systems;
- Water conservation laws and ordinances.

This guide discusses water conservation strategies, gives sources of water conservation information, and relates practical advice on beginning a conservation program. The information contained in the guide is based, in part, on the authors' research experiences. The guide should be of interest and value to water utilities, planners, environmental and citizens' organizations, and individuals concerned with increasing the efficiency of our nation's water systems.

Why Conserve Water?

Energy Savings

The fastest growing cost in the nation's water budget is the energy needed to pump water from one place to another. On an individual basis, it is likely that the average homeowner pays more for energy i to heat water than for all the water used. Domestic water heating consumes 3 percent of the total national energy budget. Saving water will save energy, which, in turn, will save money on water and heating bills, as well as on municipal energy costs.

Reduction of Environmental Impact

Citizens and the government are becoming more sensitive to the negative impacts that developing new water supplies has on our environment. It is becoming increasingly difficult to create "new" water by damming wild rivers or diverting water from one natural drainage basin to another. A more subtle environmental impact is the intrusion of saltwater into freshwater aquifers and land surface subsidence due to unwise water withdrawals. These areas are often close to metropolitan population centers where the water is needed the most. The implementation of water conservation programs could minimize or even avoid such environmental impacts and also delay the need for the creation of "new" water supplies.

Reduction of Sewage Flow

Reducing per capita water consumption will reduce the amount of sewage produced and increase the "life" and capacity of many treatment plants. This implies a decrease in the construction of new sewage treatment plants, as well as a drop in the size of the new systems. Homeowners with individual on-site septic systems can also benefit from conserving water by reducing the hydraulic load on overloaded or improperly designed systems, thus postponing the need to incur extensive replacement costs.

Elimination of Sewage Hookup Moratoriums

Many communities have sewage treatment plants which are overloaded and can no longer accept additional volumes of flow. In order to protect the bodies of water into which these sewage treatment plants discharge, state governments often impose sewer hookup moratoriums. These moratoriums prevent additional housing construction activities from taking place, therefore, effectively halting growth. An overall reduction in water use would mean that more homes could be built in a given area without adding sewage treatment plant capacity.

Capital Costs Reduction

Government and business are required to make capital investments to adequately meet the community's need for water. Water systems include costly water treatment plants, pumping plants, reservoirs, aqueducts, and pipes. Reductions in water use would delay the enlargement of these facilities. The initial size of water distribution systems large enough to handle peak demands may also be decreased.

Demand Management In Crisis and Noncrisis Situations

Community water conservation programs are most often established as an emergency coping response to an acute drought situation. Regional and local droughts occur almost annually somewhere in the United States. Other emergency situations which might mandate conservation include a local crisis, such as the failure of a water treatment plant or plant component, or a hazardous substance spill.

Four situations which most frequently lead to the establishment of community water conservation programs are drought, major water shortages because of pollution of an aquifer, rapid growth or equipment failure, and sewer hookup moratoriums.

The new role envisioned for water conservation programs is as an integral part of long-term resource planning during noncrisis situations. From this perspective, water conservation might be more appropriately termed "water demand management" in contrast to "water supply management." This strategy envisions conservation programs as a means of reducing demand vis-'a-vis traditional water resource programs which seek to supply all the water the public wants.

Starting a Water Conservation Program in Your Community

The decision to begin a water conservation program most often arises as a result of a need perceived by community leaders or decision makers. The perceived need may be to save energy, reduce environmental impact, eliminate sewer hookup moratoriums, lower capital cost, manage demand in a noncrisis situation, or cope with an emergency situation.

It is important that water conservation be built into any water supply master plan for a community. Planned water conservation will necessitate the initiation of a community water conservation program so that future water supply will be adequate. If conservation is recommended by a water planning consultant, it is documentation which the governing body can use to justify appropriating the funds necessary to begin work.

Private investor-owned water utilities are less likely to embrace the concept of conservation. The more water they can sell, the larger their profit potential. However, if your community is served by an independent water utility, a water conservation program initiated by a citizens' group is still very worthwhile.

Many utility managers argue, with good reason, that conservation will result in rate increases necessitated by the loss of revenue to the utility from reduced water use. Although rates may rise in response to an effective water conservation program, there are still good reasons why individual customers will show a net benefit from a community water conservation program. They are:

- Individual household conservation should be higher than the community average because of factors such as unaccounted-for water, uses unaffected by conservation, and less than 100 percent participation by all water users in the conservation program. If the water rate is based on the average water reduction for the community as a whole, individuals who conserve will undoubtedly save more than the average. The difference will be a definite savings to those individuals.
- Savings in inflation costs of water will nullify any costs to the customer resulting from conservation.
- Customers will enjoy energy and sewer service savings on top of water cost savings. It is highly unlikely that both energy and sewer rates will rise in tandem with water rates.
- In most cases customers will reap enough benefits while the rate increase is going through the approval process to pay any costs that they might suffer.

There are other reasons why the customers are better off with water conservation, but the ones cited above are the most significant. In any case, a community-wide water conservation program will reward those who participate with savings in excess of their costs.

Once the decision to begin has been made, a variety of approaches are possible. The important thing to remember in conducting a successful program is careful pre-planning and thorough execution. You should plan on pilot testing your program before attempting any expensive, large-scale effort. Much of the effort involves public relations; citizens need to know that their leaders are behind the program and that it is beneficial to them as individuals. An excellent resource for communities interested in beginning a program that involves retrofit of water conservation devices is available from the California Office of Water Conservation, 1416 Ninth St., P.O. Box 942836, Sacramento, CA 94236-0001. It is entitled *How to do a Residential Retrofit Program: Water Conservation Guidebook No. 1.*

The following summary of several successful programs around the country could serve as models.

Washington Suburban Sanitary Commission, Maryland

The commission pioneered a water conservation program in 1970 as a result of a sewer crisis. The program was aimed at 1.3 million residents in two Maryland counties. Preliminary work began in 1970 with the development of some customer flyers and publicity shorts on the value of conserving water to reduce waste and cut customer bills. Because the early efforts were well received, the program was expanded to a Customer Water Saving Idea Contest which led to the production of the *WSSC Water Saving and*

Waste Reduction Handbook. The commission pursued other projects during 1971-73. The activities included (1) the organization of water saving workshops for property managers in the service area; (2) the development of a slide-tape program on water saving for presentation to civic and service organizations; (3) the preparation of a set of twelve television and radio public service spot announcements; (4) the maintenance of a continuing news-publicity program, including the production of regular features, pictorial reports, and progress releases about the program; (5) the production of publicity aids about saving water, including bumper stickers, buttons, stickers, and T-shirts; and (6) the passage of code changes requiring water conservation devices in new construction.

Another aspect of the conservation effort included a Bottle Kit program using Boy Scouts and college students to deliver the kits. Each kit consisted of three l-quart plastic bottles to displace water from the toilet tank, two dye tablets to check for leaking toilets, and a copy of the *WSSC Water Saving and Waste Reduction Handbook.* This entire program resulted in an estimated 4.42 percent reduction in water consumption throughout the district during the period. In addition, a significant reduction in sewage flows to the treatment plant was observed.

In the spring of 1974 the commission continued its program by offering shower control insert devices (to reduce shower flow to 3 gallons per minute). The device was offered through a special pamphlet inserted into regular quarterly water bill mailings. Over 300,000 of the devices were distributed.

The WSSC continued to support new projects designed to improve its tools for water conservation education. These projects included (1) water-saving and waste-reduction poster contests; (2) the formation of a WSSC conservation club; (3) the production of a 20-minute water conservation film entitled *Drip;* and (4) the development of a handbook on saving outside water, called *Keeping the Garden Green.* The WSSC program has served as a model for many other water utilities around the nation.

The WSSC also enacted a water conservation rate structure that charged more for a given unit of water as the use of water increased. Thus, a customer whose average daily use of water was 160 gallons paid more for each gallon than a customer whose use was 150 gallons. The more water used, the greater the price difference.

City of Elmhurst, Illinois

The major elements of this program were (1) a public information program; (2) rate changes to reduce usage; (3) plumbing code amendments requiring water efficient fixtures; (4) controls on outdoor use of water; and (5) a water-saving device refit program.

The public information portion of the water conservation program was most important. Elmhurst's experience has been that once its residents were made aware of the problem, they worked hard to solve it. The program included water bill mailing inserts, newsletters describing water supply problems, suggested methods to conserve water, and an explanation of the conservation program. Local newspaper, radio, and television provided excellent coverage of the water supply problem and water conservation program.

The city decided that the most equitable rate structure for a primarily residential community was a uniform unit charge. It instituted an excess facilities water rate which established a base consumption for a three-month period during the winter. Water used during summer billing periods that exceeded base consumption by 30 percent or 600 cubic feet, whichever was larger, was charged at a higher rate. Elmhurst felt that the excess facilities rate provided an incentive for water conservation.

Elmhurst decided that a refit program was necessary, and the city council passed a resolution requiring all toilets, where technically feasible, to be refitted with displacement dams by January 1978. The city delivered to each home a set of displacement dams, shower flow control devices, and dye tablets to check for toilet flush tank leakage. If the resident was at home, an offer was made to install the dams. If the individual was not at home, the devices were hung in a plastic bag on the doorknob with a letter of introduction from the mayor, instructions on how to install the devices, plus a postage-paid postcard for residents to request installation assistance. The program was reported to be successful, with cooperation obtained from nearly every resident.

Casa-del-Agua, Arizona

Casa-del-Agua is a unique research and demonstration facility located in Tucson, Arizona, and sponsored in part by the city of Tucson. It is a private residence for two individuals who assist with data collection for the various water conservation methods being evaluated. The home is open for tours to educate others about residential water conservation. 'Me five major features of Casa-del-Agua are (1) a rainwater harvesting system; (2) a gray water recycling system; (3) minimum water-demand native landscaping; (4) water saving fixtures; and (5) a solar greenhouse. Information about Casa-del-Agua is made available to those who tour the facility and via the distribution of publications to residents of the region.

East Brunswick Township, New Jersey

The distinguishing feature of this program is that it was conducted during a noncrisis situation in a relatively affluent community. The program included (1) free distribution of water conservation kits, along with a public information program; (2) a rate change to reduce usage; (3) plumbing code amendments requiring the installation of water-efficient fixtures; and (4) controls on

outdoor water usage. The program began in 1978 with controls on outdoor water usage. Outdoor watering was banned between 11:00 am. and 6:00 p.m., Monday through Sunday, and filling of swimming pools was prohibited on Friday, Saturday, and Sunday.

The free distribution of water conservation kits was limited to a sample of approximately 6 percent of the community (650 homes). The water conservation kit consisted of a shower flow restrictor, two toilet dams, a faucet aerator, and a faucet flow restrictor. When the free distribution program was analyzed by statistical methods, a saving of 4.38 percent of the total indoor domestic water use could be projected annually. This compares favorably with a 3 percent reduction reported by Morgan in a similar study in Oxnard, California.

Also as part of this program, water saving showerheads were offered for sale at cost by the township. The result of this part of the study was not good; fewer than 5 percent of the homeowners in the sample installed the showerheads. A door-to-door distribution of free showerheads would have been more successful. Hamilton Township, New Jersey, reported a 65 percent installation rate for water saving showerheads distributed door to door.

An increasing block water rate charge was selected as the most equitable method of encouraging water conservation. This was based on a surcharge system. The greater the water consumption, the higher the surcharge. No allowance was made for the number of people in particular households.

The following is a suggested sequence to be used in initiating a community water conservation program. It is only a guide; a complete program must be tailored to the overall objectives of the community.

Steps in a Water Conservation Program

Step 1. Plan a consumer education program. Begin with focusing on the need for water conservation, community water problems, and alternatives which are feasible. The potential for water conservation programs should be discussed, including the planning of water conservation programs, rationale behind certain proposed actions, and monetary benefits to the consumer.

Step 2. Initiate a program of water conservation in public facilities, such as schools, colleges, hospitals, prisons, and municipal buildings, including a leak detection program, full metering and refitting of public facilities with water saving devices, and seminars for public employees.

Step 3. Start a leak detection and water meter maintenance program for the entire water distribution system.

Step 4. Pass an ordinance regulating outdoor water use and encourage water-efficient landscaping.

Step 5. Plan workshops for plumbers and builders on the need for water saving equipment.

Step 6. Amend the building code or pass an ordinance to require the use of water saving equipment in new construction.

Step 7. Restructure the pricing system to discourage high-volume water use by pricing on marginal cost basis; and collect revenues due to losses from reduced water consumption.

Step 8. Identify high water users in the commercial and industrial sector and approach them with specific water conservation plans for their facilities. Examples of such facilities would include office buildings, hotels, motels, gas stations, restaurants, and individual industrial plants.

Step 9. Plan a refitting program using water saving devices, including toilet displacement bottles, flow control-aerators, shower flow controls, etc. A pilot test program should be started before a large-scale program is begun.

Community Water Conservation Strategies

Public Education Programs and Conservation Plans

Public education programs on conservation may prove to be the best way of bringing about substantial water savings. Long-term, ongoing programs can promote a conservation ethic, making people more receptive to the idea of reducing water use to conserve limited water resources. Water agencies are in no position to effectively police conservation programs; they must depend on public cooperation. Public education programs should, therefore, be designed to make people more aware of the value of our water resources and the need to properly utilize and protect them. It is difficult to quantify the impact of an educational program on water use. Many diverse factors influence consumption rates, including climate, water pricing policies, and the socioeconomic level of consumers.

Educational programs can stress the positive economic benefits to the homeowner and the environmental benefits to the community, or can inform the consumer of the function and proper use of available conservation measures.

In order to begin an educational program, it is important to plan and consider (1) the type of program, (2) duration of the program, (3) amount of funding available, and (4) sponsoring organizations. The constraining factors are time, money, and availability of professional personnel. To date most of the educational programs and demonstration projects undertaken by governmental agencies around the nation have been undertaken without federal financial assistance. Potential savings for manpower and funds can be realized if there is better coordination between state and federal programs, and by combining conservation programs with the various federally funded public participation programs within the state. There are several types of public information programs which have been successfully started and carried out around the country. General information about two of these programs may be found in the following publications.

Water Management Plan, City of Austin, Resource Management Department, 3000 South Fountain Park Plaza, Austin, TX 78704

Urban Water Management Plan, East Bay Municipal Utility District, Publications Office, P.O. Box 24055, Oakland, CA,94623

School Programs

As water users, children can exert a great impact on their families' water consumption. Water conservation programs in the classroom may be facilitated by the following media sources geared specifically toward children:

The Story of Drinking Water. A picture presentation designed to acquaint the elementary or middle school student with the history, accomplishments, and workings of public water supply systems. Entertaining, instructive. 16 pp. One "teaching aid" booklet provided free with every 50 copies. Samples and quantity prices on request (No. 70001).

Water Conservation: It's Up to You! Cartoon color slide show. 13 minutes. Featuring Beauregard Beaver with water saving tips for children. Recommended for grades I through 4, these programs are available from: American Water Works Association, Publication Order i Department, 6666 W. Quincy Avenue, Denver. CO 80235

Instructor's Guide to Water Education Activities. Public school education program. Pennsylvania Water Conservation Technical Assistance Section. Department of Environmental Resources, P.O. Box 1467, Room 212, Harrisburg, PA 17120. 1982.

How to do an In-School Education Program. California Office of Water Conservation, Office of Water Conservation, 1416 Ninth St., P.O. Box 942836, Sacramento, CA 94236-0001.

Project Water (Water Awareness Through Education and Research). A water conservation education program developed by the East Bay Municipal Utility District. Employing water as the setting, the program has colorful exercises, puzzles, maps, and charts and covers many disciplines of study. Materials have been designed for implementation in four grade level groupings: grades K-3, *Water Play; 4-6, Captain Hydro ;* 7-8, *The Further Adventures of Captain Hydro;* 7-12, *Water Conservation: Home, Science, Community.* For the greatest short-term and long-term impact, *Captain Hydro is* recommended. Additional aids available for use on this level include Captain Hydro buttons and T-shirt iron-ons, which are used as interest stimulators in water conservation or as classroom prizes for students who become super water savers. Also, there is a two-part filmstrip, The *Adventures of Captain Hydro,* comprised of a full-color reproduction of the comic art of the Captain Hydro workbook. This visual aid introduces the program or can be used as a tool in teaching reading. Contact: Innovative Communications, 207 Coggins Drive, Pleasant Mts., CA 94523. Telephone (415) 944-0923.

Water-Utility-Assisted Programs

Bill inserts are one way water companies can offer information directly to their customers. In utilizing this method of public education, care should be taken in designing or providing a bill insert that will attract attention, while avoiding the appearance of junk mail. Information which water utilities can obtain and send to their customers includes:

Water Conservation at Home. An envelope stuffer that explains why, where, and how the consumer can avoid wasting water. A simple illustration on how to read and interpret one's own water meter is included. 14 pp. Samples and quantity prices on request (No. 70006).

Water Conservation Pamphlet Series. This series of four envelope stuffers was published to complement booklet No. 70006. All four stress water conservation. Samples and quantity prices on request. *By the Dawn's Early Light,* No. 70011. *Be a Leak Seeker,* No. 70012. *25 Things You Can Do to Prevent Water Waste,* No. 70013. *5 Basic Ways to Conserve Water,* No. 70014.

Address order to: American Water Works Association, Publication Order Department, 6666 W. Quincy Avenue, Denver, CO 80235. Telephone (303) 794-7711

It's Up to You. Basic water saving handbook.
Apartment Water Saving Handbook. Keeping the Garden Green. Lawn and Garden Care Conservation Handbook.
Costly Drip. Leak check- list and faucet repair system.
What Can I Do? Single sheet, two sides of water saving ideas.
I Save Water Stickers. Can be attached to sinks and tubs as a reminder to family members on water saving.
Drip Kit for toilet leak detection.
For sample copies and more information write: Public Affairs Office, Washington Suburban Sanitary Commission, 4017 Hamilton Street, Hyattsville, MD 20781.

Programs for Reducing Outdoor Water Demand

Several water usage tips can be offered to the consumer to reduce outdoor water demand. These can be made part of an educational program and printed on consumers' water bills.

- Water the lawn in the early morning. This prevents lawn diseases which may occur if the lawn is watered in the evening and avoids evaporation losses associated with daytime watering.
- The key to successful lawn irrigation is to irrigate slowly, deeply, and infrequently.
- Do not allow irrigation water to flow into a gutter or street.
- Keep a record of the frequency of watering and amount of water used to establish the best watering schedule.
- Aerate the lawn regularly to increase its ability to absorb moisture to the root level.
- Dig basins around the "drip line" of trees and shrubs; it saves water and is better for your plants.
- Flooding and soaking are the best ways to water trees and shrubs.
- Use an alarm clock or the stove timer to remind you to shut off the sprinklers.
- Keep sprinkler heads clean to prevent uneven watering, and make sure they are located correctly to cover the greenery and not the paved areas.
- Avoid sprinklers that produce a fine mist; too much water is lost in wind and evaporation.
- Use pistol-grip nozzles (spring shut-off) on all hoses to avoid waste, and to prevent leakage always turn off the faucet when watering is completed.
- Try "trickle" or "drip" irrigation systems in outdoor gardens. These methods use 25 to 50 percent less water than hose or sprinkler methods. A tiny plastic tube runs along the ground near plants. The trickle system provides many tiny holes to water closely placed plants. The drip system tubing contains holes or openings at strategic places for tomatoes and other plants that are more widely spaced.
- If water is rationed or otherwise restricted, lawns and annuals should receive the lowest priority for outside watering. Trees and shrubs are more, expensive to replace and should receive any available water.
- Cover the bare soil around yard plants with a mulch to reduce evaporation. Lawn clippings, leaves, peat moss, and plastic are good materials to use for this purpose. Mulching also controls weeds that compete with garden plants for water.
- Water established lawns no more than once a week or not until they show signs of wilting. Many will survive if watered only once a month. Do not sprinkle in windy weather.
- Consider delaying the planting for new lawns. If not, sow early to enable the lawn to become established. A fine, firm seed bed kept moist the first few weeks is needed to establish a new lawn.
- During the hot summer months, raise the blade on the lawn mower to 1-1/2 inches in height. This provides shade for the roots and helps reduce water loss.
- Figure out how much water you are using outdoors; a half-inch hose at normal home water pressure delivers about 600 gallons of water per hour, 5/8- inch carries about 1,000 gallons per hour, and 3/4-inch carries 1,900 gallons per hour 9 Use a broom, not the hose, to clean the garage, the sidewalks, and the driveway.
- Determine the amount of water you are using outdoors by comparing water bills for the summer and winter.
- Look at the family's recreational habits and attitudes to decide if water is being used unnecessarily.

Media Programs

Public information activities involving newspapers and radio and television stations can be helpful in disseminating information. The use of films and videotapes can reach a wide audience within the community and can be repeatedly used for maximum viewing.

Films and film sources include: *Drip.* 20 minutes, color, sound, 16 mm only, motion picture showing residential water users how to conserve. This film is available from: American Water Works Association, Publications Order Department, 6666 W. Quincy Avenue, Denver, CO 80235.Telephone (303) 794-7711.

You'll Never Miss the Water. 20 minutes, color, sound, 16mm only, motion picture describing the need for water conservation and showing how to conserve. This film is available from: Walter J. Klein Co., Ltd., 6301 Carmel Road, Charlotte, NC 28211.

Cooperative Extension Programs

Your county has an office for cooperative extension where water conservation materials and publications are available for use in public education programs. In addition, extension office personnel may be able to put you in contact with other extension professionals who may have specialized water conservation knowledge. Extension personnel may also be quite helpful in assisting with the planning and execution of a water conservation program- Contact the county agent at cooperative extension for further information.

Additional Water Conservation Program Materials

The following list of materials can be used to support any or all of the previously mentioned water conservation programs.

How Saving Water Saves Energy. The Metropolitan Water District of Southern California, 111 Sunset Boulevard. Los Angeles, CA.

Water Conservation Checklist for the Home. Program Aid No. 1192, U.S. Department of Agriculture, Extension Service.

Water: Time to Start Saving? Consumer Reports, May 1978, p. 294.

Designing a Public Information Program for Water Conservation, 1984. State of California, Office of Water Conservation, P.O. Box 388, Sacramento, CA 95802

Other Sources of Program Support

Certain organizations, ranging from the federal government to local water utilities, could be recruited to administer and fund an educational program. Environmental organizations, local civic groups, or volunteers (Boy Scouts, Jaycees, rescue squads) might also be enlisted for help. State government could initiate a statewide awareness program. Projects directed at homeowners are best organized at the local level. Interaction with colleges or universities is useful for developing research aimed at quantifying the effects of conservation techniques. Municipal government is most effective in initiating local school programs and distributing materials. A special water tax has been widely used to fund programs at the local level.

Refit Programs Using Water Saving Devices

Water saving devices offer an inexpensive and lasting approach to conservation. The devices can be installed and used without major disruptions in water use habits; consequently, they offer a more palatable approach to water conservation for the American consumer.

Plumbing fixtures and systems have long been designed to ensure that a more than adequate flow of water was available to meet whatever demand was necessary. No thought was given to the design of fixtures and systems based more precisely on the needs of the water user. Consequently, pipe and fixture sizes and designs have encouraged the use of water far in excess of that really necessary to do the job. Water conservation devices help eliminate this waste by allowing only the necessary amounts of water to be used at the plumbing fixture. In many cases the user does not even notice their presence. For example, toilets that look and work the same are available using 1.5 gallons of water every time they are flushed, compared with the 5 gallons required by a conventional non-watersaving type. Showerheads that automatically reduce shower water usage by up to 60 percent yet still deliver a sharp, forceful spray are available.

The major advantages of water conservation devices are that they are:

- relatively inexpensive;
- easily installed by the homeowner;
- effective in reducing water use, wasteflows, and energy consumption;
- permanent

The water conservation devices discussed in this publication have all of the above advantages.

Studies of home water use have shown that the activities of toilet flushing, bathing, and clothes washing use the most water in the average home. The chart below shows how this water is used daily by a typical family of four in the Northeast.

Activity	Gallons Used
Toilet Flushing	**77**
Shower and bathing	**58**
Laundry	**61**
Other	**79**
Total	**275**

Source: E.M Seaker and W. E. Sharpe. Water Use in Eight Central Pennsylvania Homes.

Water use outside the home for such things as car washing and lawn watering is not included in this listing. It should be remembered that of the 275 gallons used per day, all of it leaves the house as wasteflow which must be treated to prevent water pollution. Additionally, a significant amount of this water has been heated at the cost of a considerable amount of energy.

In order to save water, it makes sense to concentrate on reducing the uses which require the most water; consequently, toilets and showers are prime targets for conservation. Fortunately, some inexpensive devices are available to do this job.

Water Saving Toilets

The ordinary flush toilet uses from 4 to 6 gallons of water every time it is flushed. This is much more water than is necessary. AU flush toilets can be modified to use less water by adding weighted plastic bottles to the toilet tank. Tests have shown that up to three weighted plastic bottles can be placed in the toilet tank to reduce water use per flush. The number of bottles that can be used depends on the toilet and the type of bottles used. Water saved will be equivalent to the volume of the bottles used, so that a 1-quart bottle will save a quart of water and so on. More bottles can be added based on how well the toilet flushes with the bottles in place. Fine-tuning of the flush volume can be achieved by substituting a smaller size bottle. The recommended procedure is as follows.

Step 1. Secure three plastic bottles for each toilet in your home. Two of these bottles should be of I-quart capacity and one should be of 1-gallon capacity.

Step 2. Cut the tops out of all the bottles with a sharp pair of scissors.

Step 3. Add enough small stones to the bottles so that they do not move around when submerged in the toilet tank.

Step 4. Fill the plastic bottles with water and place them in the toilet tank wherever they will not interfere with the flush mechanism. Eliminate any bottles that do not fit into the tank.

Step 5. Use the toilet for a period of time. If flushing problems are encountered, reduce the size of the 1 -gallon bottle by cutting a portion of it away.

Step 6. If flushing problems persist, remove the 1-gallon bottle entirely.

A recycled 1-gallon milk jug can be used as the large bottle. Smaller bottles can be purchased from: Graham Container Company, 500 Windsor Street, P.O. Box 2618, York, PA 17405-2618.

Up to 30 percent of the water used for toilet flushing can be saved using weighted plastic bottles. The exact wnount of savings will vary.

If a new toilet is to be installed, a low-volume model should be selected. These toilets are designed to use 1.5 gallons of water every time the toilet is flushed. Low-volume toilets are available from several manufacturers. Consult the Rocky Mountain Institute or the Plumbing Manufacturers Institute for a listing (in bibliography).

Water Saving Showers

Several different brands of inexpensive water saving devices are on the market that limit shower flow rates to 2 gallons per minute (gpm) while giving a forceful, pleasing shower. These showerheads deliver a very fine spray which cannot be adjusted. Installation, where the shower arm does not end in a ball joint, is quite simple. Just remove the existing showerhead by turning it counterclockwise with an adjustable wrench, while being careful not to twist the shower arm. Place some Teflon tape or pipe dope on the exposed threads and thread on the water saving showerhead by turning it clockwise. For ball-joint showerheads a special adapter or a new shower an-n will be necessary. If an adapter is used, turn it into the threaded ring around the ball until snug. Then thread the water saving showerhead onto the other end of the adapter. There are three widely used types of ball joints; each requires a special adapter. If adapters are not available, the shower arm can be replaced with a nonball-joint shower arm. This operation is a little tricky in that the shower arm is attached inside the shower wall. Rotating the shower arm counterclockwise will free it from the threaded elbow that it is attached to in the wall. A new shower arm with its thread dressed with Teflon tape or pipe dope can then be inserted into the elbow and tightened by rotating it clockwise. Because this fitting is behind the wall, it is important that it not leak. If an access panel is available behind the shower wall, it should be opened to check for leaks after the installation is complete.

The 2-gpm showerhead has been shown through research to reduce shower water usage by 30 to 60 percent. The actual amount of savings will depend upon the type of showerhead that is replaced and the water pressure. In most applications these showerheads will pay for themselves in approximately one month in energy savings alone.

Water saving showerheads are preferable to the many types of inexpensive flow restrictors that can be purchased for insertion between the showerhead and the shower arm. The water saving showerhead has been designed to give a pleasing shower with its built-in flow control, but a restrictor may or may not be compatible with an existing showerhead. In addition, most restrictors limit flows only to 3-gpm, resulting in substantially reduced savings.

Water Saving Faucets

When the water flow from all faucets in the house is totaled, the sum constitutes a significant portion of household water use.

Flow rates from faucets vary widely depending upon water pressure and type of faucet. New faucets must have maximum flow rates equal to or less than 2.75 gpm. Existing faucets may have flow rates of 6 gpm or more. For most faucet uses, maximum flow rates of 0.5 to 1.0 gpm are adequate. Flow rates this low will result in significant water and energy savings.

Fortunately, there are some inexpensive methods available to cut water use from faucets. The simplest is to install flow-control aerators that use 0.5 to 1.0 gpm of water. These devices are designed to fit faucets with threaded spouts. Since faucet diameters and thread sizes vary widely, an adaptor may be necessary. Two companies-Chicago Faucet Company, 2100 S. Nuclear Drive, Des Plaines, IL 60018, and American Standard, P.O. Box 2003, New Brunswick, NJ 08903--currently offer a flow-control aerator which reduces flows to 0.5-1.0 gpm. Adapters will be necessary for a great many installations. A second adapter may also be necessary for some installations. More information on adapters is contained later in this section.

Installation of flow-control aerators is relatively simple. Just remove the old aerator by turning it counterclockwise with a large pair of pliers. Then install the flow-control aerator by turning it clockwise onto the spout until it is snug.

The Chicago Faucet and American Standard flow-control aerators will not fit many other brands of faucets, nor will they fit unthreaded faucets. For these situations, an inexpensive universal adapter can be purchased. A suggested adapter is one that is available from Wrightway Manufacturing Co, 1050 Central Avenue, Park Forest South, EL 64066. To install a flow-control aerator with this adapter follow the directions provided with the adapter

.

Cost savings to the individual homeowner will far exceed the cost of purchasing and installing water saving devices. The devices recommended for toilets, showers, and faucets should pay for themselves in energy savings alone in four to six months. This does not include the additional savings in water and sewage flow reduction. In 1988, costs for outfitting a two-bath home with devices for toilets, showers, and faucets averaged $40. Annual energy and water savings were estimated at $133 per year.

Automatic Clothes Washers

Water consumption by automatic clothes washers ranges from 30 to 70 gallons per wash load; the exact figure varies according to habits of the user and the type of washer. Washers with suds savers reuse wash water for a second wash load. Water savings may also be achieved by automatic washers that allow the amount of water used to be adjusted for load size. Front-loading automatic washers with load size adjustments reportedly use up to 40 percent less water and may be purchased when an existing washer is replaced.

Automatic Dishwashers

Newer models are available that reportedly use 20 percent less water. If purchase of an automatic dishwasher is contemplated, such a model should be considered. Otherwise try to use the dishwasher for full loads only.

Adopting a Plumbing Code Change

Many sites and local jurisdictions have adopted ordinances and plumbing code changes requiring water-conserving plumbing fixtures in new construction. Several national plumbing codes also require water-conserving fixtures. If your municipality subscribes to the BOCA plumbing code, you need merely to enforce those sections of the code dealing with water-conserving plumbing fixtures (section P- 1603.7 and P- 1603.8, page 132) to achieve water conservation in new construction.

Some suggestions for a "model" water conservation code are included below. Massachusetts was the first state to pass a law requiring low-volume toilets in new or replacement construction. The law appears below.

Section 2.14h is added to the Uniform State Plumbing Code, to read: (h) Conservation of Cold Water. Effective March 2,1989:

1. *Tank type water closets shall be low consumption toilets which use a maximum of 1.6 gallons (6 liters) per flush;*
2. *Flushometer water closets which use a* maximum *1.6 gallons (6 liters) per flush;*
3. *All other water closet types shall also be low consumption toilets which use a* maximum *of 1.6 gallons (6 liters) per flush; and*
4. *Flushometer or other urinals shall use a maximum of 1 -5 gallons (5.7 liters) per flush. The provisions of this section shall apply to all new construction as well as to renovations and replacement in existing structures after the effective* I *date of this act. In satisfaction the of requirements of this section, the examiners shall permit the installation of tank-type water closets equipped with devices which are found by the examiners to meet applicable standards in water closets having a tank capacity in excess of 1.6 gallons (6 liters). The examiners may also allow the use of standard flush water closets and urinals which do not meet the specific standards when, in the opinion of the examiners, the configuration of the building drainage system requires a greater quantity of water to adequately flush the system. The examiners shall publish or cause to be published, periodically, a list of acceptable flxtures and devices which comply with applicable standards.*

Flow Controls on Showers and Faucets

Sections P-1603.7 and P-1603.8 of the BOCA code contain the requirements for flow controls on showers and faucets. These sections appear below:

P-1603.7 Minimum required flow rates and pressures: Based on the minimum static water pressure available, pipe sizes shall be selected so that under conditions of peak demand, a minimum flow pressure and flow rate at the point of discharge shall not be less than shown in Table P1603.7, Minimum Required Flow Rates and Pressures.

In determining minimum pressures at the outlets, allowance shall be made for the pressure drop due to friction loss. P-1603.8 Maximum flow rates and pressure conditions: Water supply to showerheads, lavatories, and similar equipment shall be equipped with approved water saving devices, restricting the flow to not more than three (3) gpm.

Special attention should be paid to Section P- 1603.8.

P-1603-8.1 Mixed water temperature control: The temperature of mixed water to multiple or gang showers shall be controlled by a master thermostatic blender or such showers may be individually regulated by balanced pressure mixing valves. Individual showers in commercial and public buildings subject to rapid rise of mixed water temperature due to system pressure fluctuation shall have balanced pressure mixing valves in addition to flow rates as required under Section P-1603.7.

Where shower flow controls are used, there is likely to be an increased possibility of rapid temperature changes in shower water. Such temperature changes can result in direct injury by scalding of exposed skin or secondary injuries resulting from accidents caused by avoidance reaction to the rapid temperature change. The extent of such problems in single-family homes is unknown. If the recommendations in Section P-1603.8.1. are followed, these problems can be avoided. In single-family homes it is suggested that domestic water heaters be set at 120 F to reduce the possibility of scald injury and save energy.

Table P- 1603.7 of the BOCA plumbing code, Minimum Required Flow Rates and Pressures

Location	Flow Pressure (psi)	Flow rate at point of discharge
Ordinary basin faucet 2	**8**	**2**
Self-closing basin faucet 2	**8**	**2 ½**
Sink faucet 3/8 inch	**8**	**3**
Sink faucet ½ inch	**8**	**3**
Bathtub faucet	**8**	**4**
Laundry tub cock ½ inch	**8**	**4**
Shower 3	**8**	**3**
Ball-cock for closet 4	**8**	**3**
Flush valve for closet 1	**15**	**15-35**
Flushometer valve for urinal	**15**	**15**
Drinking fountain	**15**	**¾**
Sill cock – wall hydrant	**10**	**5**
Flush valves for wall hung, blow-out and syphon-jet water closets	**25**	**35**

Note 1. Wide range due to variation in design and type of closet flush valves.
Note 2. Lavatories in rest rooms of public facilities shall be equipped with seff-closing outlet devices which limit the flow of hot water to a maximum of five-tenths (0.5) gpm, devices which limit the outlet temperature to a maximum of one hundred ten (1 1 0) degrees F, and self-closing valves which limit the quantity of hot water to a maximum of twenty-hundredths (0.25) gallons.
Note 3. Showers used for other than safety reasons shall be equipped with flow control devices to limit total flow to a maximum of three (3) gpm per shower head.

Note 4. It is recommended that, whenever possible in new installations and alterations, water conservation water closets be installed with a maximum flush of three-and-one-half (3.5) gallons.

Water Rate Structure Revision

Several forms of domestic use rate structures are currently employed by water utilities. Many variations and combinations of these basic types exist because of the metering practice in the area, classes of use, and conditions unique to the area, including land use, growth, and social subsidy programs. Remember, metering is necessary for any pricing system other than a flat rate.

Flat Rate

Employed where meters are not used, this rate type is a flat or constant charge per unit of time regardless of the amount of water used. The constant charge usually depends on the class of use and/or the size of the service line. The charge can be collected monthly or bimonthly, but usually is billed quarterly or semiannually, even annually in some cases.

The drawback of this type of rate structure is that it actually encourages water wastage; consumers are left to reason that the more they use, the less they are actually paying on a unit cost basis, and hence, the better deal they are getting.

Uniform Rate

The uniform rate is normally applied so that, irrespective of user class or amount of water used or size of meter service, the same (uniform) rate is paid by all. More and more utilities are converting to this type, some utilities are accomplishing the conversion slowly by annually eliminating one discount rate from their declining block structures, thus softening the impact of conversion on the customers who benefit from the discount rates.

Declining Block Rates

Each customer is charged a certain amount for an initial quantity or "block" of water. The rate for succeeding blocks decreases with each block as consumption levels increase.

Increasing Block Rate

This type of structure operates very similarly to declining block rates except that the rate charged rises with increased usage. Such rate structures have been employed in very few instances, but they have the potential to achieve considerable reductions in water use. The Washington Suburban Sanitary Commission has effectively used such a rate in its conservation program.

Peak Load or Seasonal Rate

This type of rate structure may be applied with existing metering equipment but does require a more sophisticated bill calculation operation. It is designed to encourage wise use of water during the time of year when the utility experiences its peak

service requirements, which coincides with the time when water usage outside the home is highest. It does this by setting a rate based usually on winter-quarter water use for the average household and charging a premium on water use in excess of this base rate. The aim of peak demand rates is to concentrate on that component of residential use which is most sensitive to price, namely outside lawn and garden irrigation. Since most of the use exceeding the base allotment is for outside uses, the consumer has an economic incentive to avoid wasting irrigation water.

Lifeline Rate

A growing practice to discount utility service to the small user is called the "lifeline" rate. This can be done by identifying the average amount of water used in, for example, a two-person cottage or apartment unit, and applying a reduced commodity rate for amounts within the first water usage block. The state of California has required that the rate for the lifeline amount cannot be increased until rates for amounts above this level are raised 25 percent.

In addition to the above commodity rates, most water agencies levy a "minimum charge" or "readiness to serve charge" with each bill. These charges cover the costs associated with metering and with rendering bills incurred regardless of amount used. Such costs include costs of meter maintenance and replacement, water meter reading, and consumer accounting.

Reducing Water Loss In Distribution Systems

Unaccounted-for water in a distribution system results from leakage at joints, valves, service connections, and pipe breaks. In addition, meter under-registration and unauthorized use are significant factors.

A leak detection survey is one means of reducing such loss. Leaks occur due to corrosion, soil movement vibrations, and temperature stresses. The extent of damage varies with age, material, and geographic location. Internal damage resulting in leaks in mains, joints, and valves can be caused by surges, water hammer, and internal chemical corrosion of pipes from the distribution water itself. Studies have shown that the major percentage of total leakage in a distribution system occurs at specific points in the system.

Meter under-registration occurs primarily from meter slowdown with age and from meter malfunction at low flows. Meter accuracy is essential in assessing total system leakage and in collecting accurate revenues. An active meter replacement and repair program is essential to good water management Unauthorized use of water includes meter tampering, illegal fire hydrant openings, and illegal connections. Although not usually significant in terms of total water losses, unauthorized uses can affect the total volume of unaccounted-for water in a distribution system.

According to Gros in *Proceedings--National Conference on Water Conservation and Municipal Wastewater Flow Reduction*, for smaller water systems with average daily consumption less than 10 million gallons per day (mgd), it is difficult to conduct a thorough and economical survey of the system for leaks unless the unaccounted-for loss is 15 percent or more. In larger systems, with unaccounted-for percentages less than 15, a leak survey program maybe feasible because 10 percent of a high average daily consumption represents a considerable amount of water.

Another consideration is the accuracy of the master meters measuring the water delivered to the distribution system. All the statistical data used to determine the unaccounted-for percentage are dependent on the accuracy of this group of meters. An inaccurate unaccounted-for percentage could lull a water utility into a false feeling of security, which could result in excessive losses. If the true percentage were known, it might be economically feasible to consider a comprehensive leak detection survey.

The temptation should be resisted to overestimate the amount of water used for fires, unmetered municipal services, and main breaks. Studies conducted by the American Water Works Association (AWWA) have shown that, in most cases, these factors account for only 1 or 2 percent of the average daily consumption.

During a drought or a program of mandatory consumer conservation, it may be necessary to inaugurate a leak detection program, even if the unaccounted-for percentage is relatively low. This is to ensure that the utility cannot be accused of wasting water while consumers are conserving water. Therefore, in determining when a leak survey is beneficial, a careful analysis should be made of circumstances and of all the factors that contribute to water losses, using the unaccounted-for percentage as a guideline rather than a number with a fixed cutoff point.

Gros discusses two types of leak detection surveys available to communities: the listening survey and the water loss survey.

The listening survey is conducted with sound-intensifying equipment in hopes of detecting valve and hydrant sounds that will lead to the location of underground leakage. The listening survey can be conducted by a water utility using its own personnel. Unfortunately, in smaller water distribution systems this type of survey cannot guarantee that the problem will be solved. In large systems it is difficult to set up a continuing program that is the most cost-effective at all times.

In both smaller and larger systems it is impossible by sound alone to quantify the leaks so the largest leaks can be repaired first.

The water loss survey uses a combination of engineering and accounting approaches, and may require the use of a firm that specializes in solving water loss problems. Flow measurements are utilized to help determine how water is being used in the system and to determine which areas have the greatest leakage potential. The primary recording devices, master meters, and industrial meters are tested for accuracy, pump efficiencies are checked, and leaks are quantified and pinpointed for repair. An analysis of all the data that are obtained will help determine how water is being lost in the system and will define the problem so that cost-effective measures can be taken.

According to Gros, if a utility has an unaccounted-for loss between 10 percent and 15 percent, a comprehensive water loss survey would result in measures reducing the loss by 10 to 30 percent. If the unaccounted-for loss is in the 15 to 25 percent range, a reduction in loss of 30 to 50 percent might be expected. If the loss is in the 25 to 50 percent range, it is probable that the reduction would be 50 to 60 percent.

Two types of instruments used in leak detection work are the aquaphone and geophone, and the more sophisticated electronic locaters containing tubes or transistors and batteries.

The aquaphone looks like an old-style telephone receiver and is reliable and easy to use. It is used primarily for checking services for leaks and for preliminary sounding on valves and hydrants. All waterworks maintenance trucks should have an aquaphone or geophone as standard equipment

A geophone looks like a doctor's stethoscope. It is rugged, easy to use, and excellent for preliminary sounding and pinpointing leaks. It is more sensitive than the aquaphone and less sensitive than the electronic locator.

Electronic locators come in many shapes and sizes. They are more sensitive, but delicate, and require special handling when transporting and using. They are also more expensive to purchase and repair.

Other types of leakage tests include the closed meter test and the dye test. The closed meter test consists of isolating one or more sections of a pipe, shutting off all service pipes, and measuring the pressure drop in the isolated section of the pipe. The dye test involves injecting a harmless vegetable dye, under pressure, into the leaking section of the water main or service pipe. With all service pipes closed off, the dye travels toward the leak. This may be the only way to detect a leaking pipe that is located in a streambed. Leaks may also be detected by a comparison of day and night flow. This is done by comparing the measured ratio of day to night flow to typical values of what this ratio should be.

Substantial amounts of water can be conserved by leakage surveys and repairs using the methods outlined above. The individual conducting the survey must rely on skill gained through experience, common sense, patience, and hard work, if these techniques are to be successful.

Because water conservation programs can have a significant effect on future water supply needs, the traditional emphasis of water supply planning on developing new water supplies needs to be altered. When existing water supplies are made more efficient through conservation, the need for developing new supplies can be significantly reduced. Thus, it is clear that water conservation needs more emphasis by decision makers at all levels of government

A complete community water conservation program, as set forth in this guide and conscientiously applied over a 3-to-5-year period, can be expected to result in savings of 10-20 percent or more.

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